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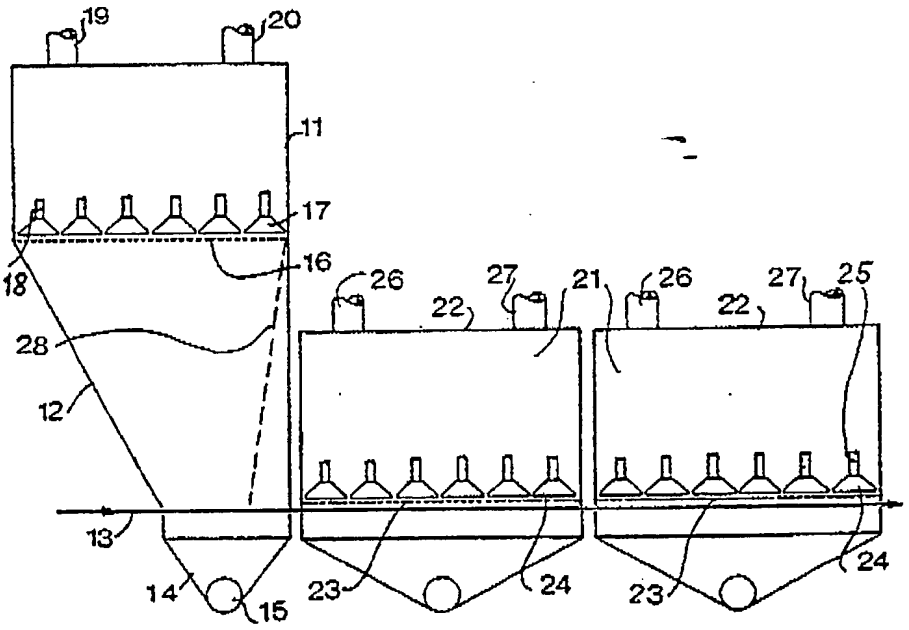

(57) Abstract

A plant for manufacturing a fibre product in the form of a web comprising at least one fibre distributor (11) which is located at the upper end of a hopper-shaped, downwardly tapered shaft (12) and having a substantially plane, perforated bottom (16) and stirrers (17, 18) which can be rotated a short distance above the bottom (16) of the fibre distributor, and having its lower end located a short distance above part of an endless forming wire (13), and a suction device (14, 15) which is located beneath said part of the forming wire (13).

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A plant for manufacturing a fibre product in the form of a web

The present invention relates to a plant of the type described in US patent specification No. 4,494,278, i.e. a plant comprising at least one fibre distributor having a substantially plane, perforated bottom and stirrers which can be rotated a short distance above the bottom of the fibre distributor, an endless forming wire which can be conveyed in a web located beneath the fibre distributor, and a suction device located beneath the forming wire.

The plant according to the invention is characterized in that the fibre distributor is located at the upper end of a hopper-shaped, downwardly tapered shaft having its lower end located a short distance from the upper side of the forming wire.

The application of a hopper-shaped shaft between the fibre distributor and the forming wire allows the use of a fibre distributor having a bottom of a relatively large area and hence a relatively high fibre discharge capacity. During the motion down through the hopper-shaped shaft of the air flow having fibres discharged from the fibre distributor suspended therein, a concentration of the fibres is effected as a consequence of the reduction in the cross-sectional area of the shaft causing a coherent fibre layer to be formed on the forming wire almost immediately. Thus, it is possible to increase the speed of the forming wire and hence the production rate of the plant. This presents a very significant technical progress since the known dry forming plants have suffer from the drawback of having a production rate compared to the known wet forming plants which is only a fraction of that of the wet forming plant.

The plant described above is particularly suitable for manufacturing thin one-layer fibre products, i.e. one-layer fibre products having a basis weight of down to 30-40 g/m², which products to a large extent are used in products of the Kleenex-type or as toilet paper.

In a preferred embodiment of the plant according to the invention the inclination of at least one of the walls of the shaft is adjustable. Thus, it is possible to vary the size of the area on the

forming wire which is covered with fibrous material.

A preferred embodiment of the plant according to the invention is characterized in comprising in addition to the fibre distributor which is located at the upper end of the hopper-shaped shaft a second fibre distributor having a substantially plane, perforated bottom and stirrers which may be rotated a short distance above the bottom of the fibre distributor, which second fibre distributor is located directly above the forming wire, and that the holes in the bottom of the second fibre distributor are significantly larger than the holes in the bottom of the first fibre distributor.

This embodiment of the plant according to the invention operates as follows:

Defibrated fibrous material from one or more defibrators, e.g. a hammer mill, is introduced into the upperlying first fibre distributor and is conveyed a motion across the perforated bottom wall under the influence of the stirrers. Preferably, stirrers disposed in rows transversely of the direction of travel of the forming wire are used as described in i.a. US patent specification No. 4,494,278, wherein the stirrers of each row may have partially overlapping areas of action. Thus, endless tubular bodies of loosely, connected fibres will be formed, which bodies move transversely of the direction of travel of the forming wire across the bottom wall, and during said motion discharge single fibres which are conveyed to the underlying second distributor after having passed the bottom wall under the influence of gravitation and the suction from the suction device.

Lumps and wads of fibre which are introduced into or formed in the first fibre distributor will be retained by the bottom wall having holes of a relatively small area (aperture area). For instance a perforated plate or a metal wire netting having square or rectangular meshes, each mesh having an aperture area of 5-8mm^2, may be used as bottom wall. The lumps and wads of fibre may be separated, e.g. by suction, and will normally be recycled to the defibrator for renewed defibration.

It is extremely important that a separation of lumps and wads of fibre is effected, since the alternative to such a separation is that the hammer mill/defibrators be adjusted in such a manner so as to shorten all fibres to an extent which renders recirculation unnecessary.

If the fibres are short, the finished product will be of a more inferior quality than if the fibres are long or unshortened in the defibrator. Shortened fibres cause the product to become weak in strength or alternatively that more binder must be used, which is expensive, and which also reduces the quality.

Also in the second fibre distributor the practically unshortened fibres which are introduced into the fibre distributor are conveyed a motion across the bottom wall transversely of the longitudinal direction of the wire. Also in the second fibre distributor the stirrers are preferably disposed in rows extending transversely of the direction of travel of the forming wire, but the number of such rows and/or their areas of action will normally be smaller than in the upperlying first fibre distributor. As mentioned, the holes in the bottom wall of the lower fibre distributor are larger than the holes in the bottom wall of the upper fibre distributor. In the use of a metal wire netting the aperture area of each mesh is e.g. 10-20 mm^2. In the same manner as explained above fibres liberated from lumps and wads of fibre will be discharged during said motion of the fibrous materiale across the bottom wall of the distributor housing. The fibres thus discharged pass down through the bottom wall under the influence of gravitation and the suction from the suction device located beneath and will be retained by the forming wire thereby forming a uniform, coherent fibre layer on the forming wire contrary to what is the case with the known plant, cf. e.g. US patent specification No. 4,494,278. The relatively large amounts of fibres which are introduced into the fibre distributor combined with the relatively limited area of its bottom wall and the relatively large holes therein cause a coherent fibre layer to be formed on the forming wire almost immediately, thereby preventing the so-called "beach shore effect" from arising, said effect being a particularly characteristic feature in manufacturing thin products, or when the speed of the forming wire is too high.

By separating the operation in which lumps and wads of fibre are separated for recirculation to the hammer mill/defibrator from the operation in which the fibrous material liberated from lumps and wads of fibre is distributed on the forming wire, it is possible to process significantly increased amounts of defibrated fibrous material, and thereby to obtain a significant increase in the capacity of the plant without reducing the quality of the fibre product formed. This is due to the fact that the aperture area of the holes in the bottom wall of the fibre distributor is not decisive for obtaining a uniform fibre product if a prior separation of lumps and wads of fibre has been effected, thereby allowing the capacity of the fibre distributor to be increased by increasing the size of the holes in the bottom wall of said distributor.

In principle, the capacity of the upper fibre distributor is almost unlimited, the capacity being proportional to the area of the bottom wall, and the capacity of the plant of the invention is therefore restricted by the performance of the underlying fibre distributor, solely. The performance of the latter depends on the aperture area of the holes in the bottom wall of the fibre distributor, but since it is not decisive for the fibre distributor as mentioned above, the performance may be increased in line with the requirements within certain limits.

It follows from the above that a high capacity in connection with a heavily increased concentration of fibres on the wire together with an even and coherent fibre distribution can be obtained by suitably adjusting the relation between the areas of the bottom walls in the two fibre distributors and the relation between the aperture areas of the holes in the two bottom walls. In this case the capacity will be higher than the capacity obtained with e.g. plants according to US patent specification No. 4,494,278.

A doubling of the area of the holes in the bottom wall of the fibre distributor allows the capacity of the underlying second fibre distributor to be increased by a factor of up to 4. Consequently, by enlarging a known plant with an extra fibre distributor and by replacing the bottom wall of the fibre distributor by a bottom wall having holes twice as big, the speed of the forming wire can be

increased by up to 300%, i.e. from the rates of 150-250 m/min used so far up to 600-1000 m/min. Hence a long existing need in the paper industry has been fulfilled.

The formation of a coherent fibre layer according to the invention further causes fibre dust or short fibres to be retained by the fibre product on the forming wire from the very start and practically eliminates the need for separating such fine particles from the suction air.

For further illustration of the significance of the area of the bottom wall of the upper fibre distributor being greater than the of the bottom wall of the lower distributor, reference is made to the following dimensioning example:

Above a forming wire having a width of 3 m a fibre distributor having a bottom wall with a width of 3 m and a length of 1.2 m is placed. Thus, the area of the bottom wall is 3.6 m^2.

The upperlying separator has a bottom wall of a width of 4.6 m and a length of 2.8 m which corresponds to an extension of the bottom wall of the separator beyond the bottom wall of the fibre distributor of 0.8 m on all sides. Thus, the bottom wall of the separator has an area of 12.88 m^2 or about 3.5 times the area of the bottom wall of the distributor. If the extension on all sides is 0.36 m only instead of 0.8 m, the bottom wall of the upper fibre distributor will have an area twice the area of the bottom wall of the lower fibre distributor, and thus a fibre concentration which is twice as high as the one obtained with a known plant, e.g. a plant as described in US patent specification No. 4,494,278, can be obtained.

In the plant of the invention the area of the bottom wall of the first fibre distributor is preferably at least twice, and more preferably 2-4 times, the area of the bottom wall of the lower fibre distributor. The area of the holes in the bottom wall of the underlying fibre distributor is preferably at least 1.5 to 2.5 times the area of the holes in the bottom wall of the upperlying fibre distributor, a doubling of the hole area in the second fibre distributor resulting in a triple or quadruple increase in the

capacity.

In the following the invention will be described in further detail with reference to the drawing in which

Fig. 1 shows a perspective view of a plant according to the invention,

Fig. 2 shows a schematic vertical sectional view of a plant according to the invention which is built together with two known plants and as seen from the side,

Fig. 3 shows a schematic vertical sectional view of a preferred embodiment of the plant according to the invention as seen from the side and partially in section,

Fig. 4 shows a schematic sectional view of the plant according to Fig. 3 as seen from the end and partially in section,

Fig.5 shows a schematic view of a further embodiment of a plant according to the invention as seen from the side and partially in section, and

Fig. 6 shows the bottom of a fibre distributor as seen from above.

The plant shown in Fig. 1 comprises a distributor housing 1 which is located at the upper end of a hopper-shaped shaft 2 having its lower end located proximate to a forming wire 3. A suction box 4 having a suction pipe 5 is located beneath the forming wire 3 in extension of the shaft 2.

The distributor housing 1 is connected to a pipe 6 for inlet of dry defibrated fibrous material and a pipe 7 for discharge of fibre lumps.

The plant which is shown in Fig. 2 comprises a fibre distributor 11, which is located at the upper end of a hopper-shaped shaft 12 having its lower end located proximate to a forming wire 13. Beneath the forming wire 13 a suction box 14 having a suction pipe 15 is

located. The distributor 11 comprises a bottom 16 provided with holes and six rows of stirrers, each comprising a stirring blade 17 and a vertical shaft 18. The shafts 18 are connected to driving means (not shown). Furthermore the distributor 11 is connected to a pipe 19 for introducing dry defibrated material and a pipe 20 for removal of fibre lumps.

The plant shown in Fig. 2 further comprises two fibre distributors 21 of a know type. The fibre distributors 21 each comprise a housing 22 having a plane perforated bottom 23 and six rows of stirrers in the form of stirring blades 24 and shafts 25 which are connected to the driving means (not shown). The distributor housings are each connected to a pipe 26 for introducing dry defibrated fibrous material and a pipe 27 for removal of lumps and wads of fibre.

The apparatus shown in Fig. 2 operates as follows:

Defibrated fibrous material from a defibrator (not shown), e.g. a hammer mill, is introduced into the distributor 11 through the pipe 19 and in the distributor it is conveyed a motion parallel to the bottom 16. During this motion part of the fibrous material will, due to the influence of gravitation and the suction from the suction box 14, be carried through the bottom 16 and down into the shaft 12, wherein a gradual concentration of the fibrous material will take place thus causing a coherent layer to be formed thereon immediately upon contact with the forming wire.

The initial layer thus formed has a coherence which is high enough to allow a fast moving forming wire 13 to carry it out of the shaft 12 and to beneath the subsequent fibre distributors 21 having bottoms 23 through which fibrous material is discharged, and which is deposited onto the layer initially formed so as to form a layer of greater thickness.

The shaft wall being adjacent to the first fibre distributor 21 may be pivotal as shown with a broken line 28 in the drawing thereby allowing the size of the area onto which fibres are deposited, and hence the thickness and the coherence of the initial layer, to be varied.

Fibre lumps which are introduced into or formed in the fibre distributor 11 are discharged through the pipe 20, and preferably recycled to the defibrator. This also applies to the lumps and wads of fibre in the distributors 21. These lumps and wads of fibre are removed through the pipes 27.

The plant which is shown in Fig. 3 and Fig. 4 comprises a first fibre distributor 50 which is located at the upper end of a hopper-shaped shaft 51 having its lower end located proximate to a forming wire 52. Beneath the forming wire 52 a suction box 53 forming an extension to the shaft 51 is located. The suction box 53 is connected to a suction pipe 54.

The fibre distributor 50 comprises a bottom 55 provided with holes and nine transverse rows of stirrers 56, each row comprising fifteen stirrers. Each stirrer 56 comprises a stirring blade 57 which is mounted on a rotatable shaft 58 which is connected to driving means (not shown). The distributor 50 is connected to two introduction pipes 59 for dry defibrated fibrous material and two pipes 60 for discharge of lumps and wads of fibre.

The lower end of the shaft 51 has a bottom 61 provided with holes 61, the holes in the bottom 61 having a larger aperture area than the holes in the bottom 55.

Four transverse rows of stirrers 62 are located above the bottom 61, each row comprising ten stirrers. The stirrers 62 are constructed in the same manner as the stirrers 56 in the distributor 50.

The fibre distributor 50 operates in the same manner as the fibre distributor 11 described in connection with Fig. 2, but while the fibrous material discharged from the fibre distributor 11 may pass directly down onto the forming wire 13, the material discharged from the fibre distributor 50 is subjected to a further influence before reaching the forming wire 52. Thus, while still in the area above the bottom 61 it will be forced into a motion parallel to the bottom 61 so as to improve the fibre distribution in the longitudinal and transverse direction of the web material.

As mentioned above the holes in the bottom 61 are relatively larger, and, therefore, the relatively large amounts of fibrous material deriving from the fibre distributor 50 will quickly pass through the bottom 61 under the formation of an even and coherent fibre layer on the forming wire 52.

The plant shown in Fig. 5 comprises an upper fibre distributor 70 which is located at the upper end of a hopper-shaped shaft 71 which terminates a short distance from a forming wire 72 which is conveyed in contact with two guide rollers 73.

The upper fibre distributor 70 comprises a distributor housing 74 having two introduction pipes 76 for introducing defibrated fibrous material and two pipes 77 for removal of lumps and wads of fibre from the distributor housing 74. At the bottom the distributor housing 74 is delimited by a bottom in the form of a netting 78, and above the netting-formed bottom 78 four rows of stirrers are located, each stirrer comprising a stirring blade 79 and a shaft 80 which is driven by a motor (not shown). A bottom in the form of a netting 81 is provided at the lower end of the shaft 71, and above the bottom 81 a row of stirrers is located, each stirrer comprising a stirring blade 82 and a shaft 83 which is driven by a motor (not shown). As will appear from Fig. 5 the shaft has side walls 84 which terminate a short distance from the forming wire 72.

A suction box 85 having a suction pipe 81 for outlet of air from the suction box 85 is located beneath the forming wire.

The plant shown operates substantially as the plant according to Fig. 3 and Fig. 4, however, in comparison with the plant shown in Fig. 3 and Fig. 4 a thicker and more coherent fibre layer is obtained on the forming wire. This is due to fact that air is taken into the area between the guide roller 73 on the up-stream side of the shaft 71 and the end wall of the shaft 71 on the up-stream side. The air thus taken in will move the fibrous material which is liberated from the netting bottom 81 in the direction of travel of the forming wire and thereby contribute to reducing the area onto which the fibre material is deposited.

Fig. 6 shows a fibre distributor 90 having a bottom 91 above which four rows of stirrers are located, each stirrer consisting of a stirring blade 92 and a shaft 93. As will appear from Fig. 6 the stirrers are located in such a manner that the areas of action of the stirring blades partially overlap each other. Between the four rows of stirrers support elements 94 are located, e.g. in the form of streched metal wires, which support a motion of tubular fibre elements across the bottom 91 of the fibre distributor 90 in the directions indicated by the arrows 95.

C l a i m s

1. A plant for manufacturing a fibre product in the form of a web and comprising at least one fibre distributor having a substantially plane, perforated bottom and stirrers which can be rotated a short distance above the bottom of the fibre distributor, an endless forming wire which can be conveyed in a web located beneath the fibre distributor, and a suction device located beneath the forming wire, c h a r a c t e r i z e d in that the fibre distributor is located at the upper end of a hopper-shaped, downwardly tapered shaft, having its lower end located a short distance from the upper side of the forming wire.

2. A plant according to claim 1, c h a r a c t e r i z e d in that the inclination of at least one of the walls of the shaft is adjustable.

3. A plant according to claims 1 or 2, c h a r a c t e r i z e d in comprising in addition to a fibre distributor which is located at the upper end of the hopper-shaped shaft a second fibre distributor having a substantially plane, perforated bottom and stirrers which may be rotated a short distance above the bottom of the fibre distributor, which second fibre distributor is located directly above the forming wire, and that the holes in the bottom of the second fibre distributor are significantly larger than the holes in the bottom of the first fibre distributor.

4. A plant according to any of the preceding claims, c h a r a c - t e r i z e d in further comprising at least one fibre distributor known as per se which is located on the down-stream side of the shaft.

FIG.1

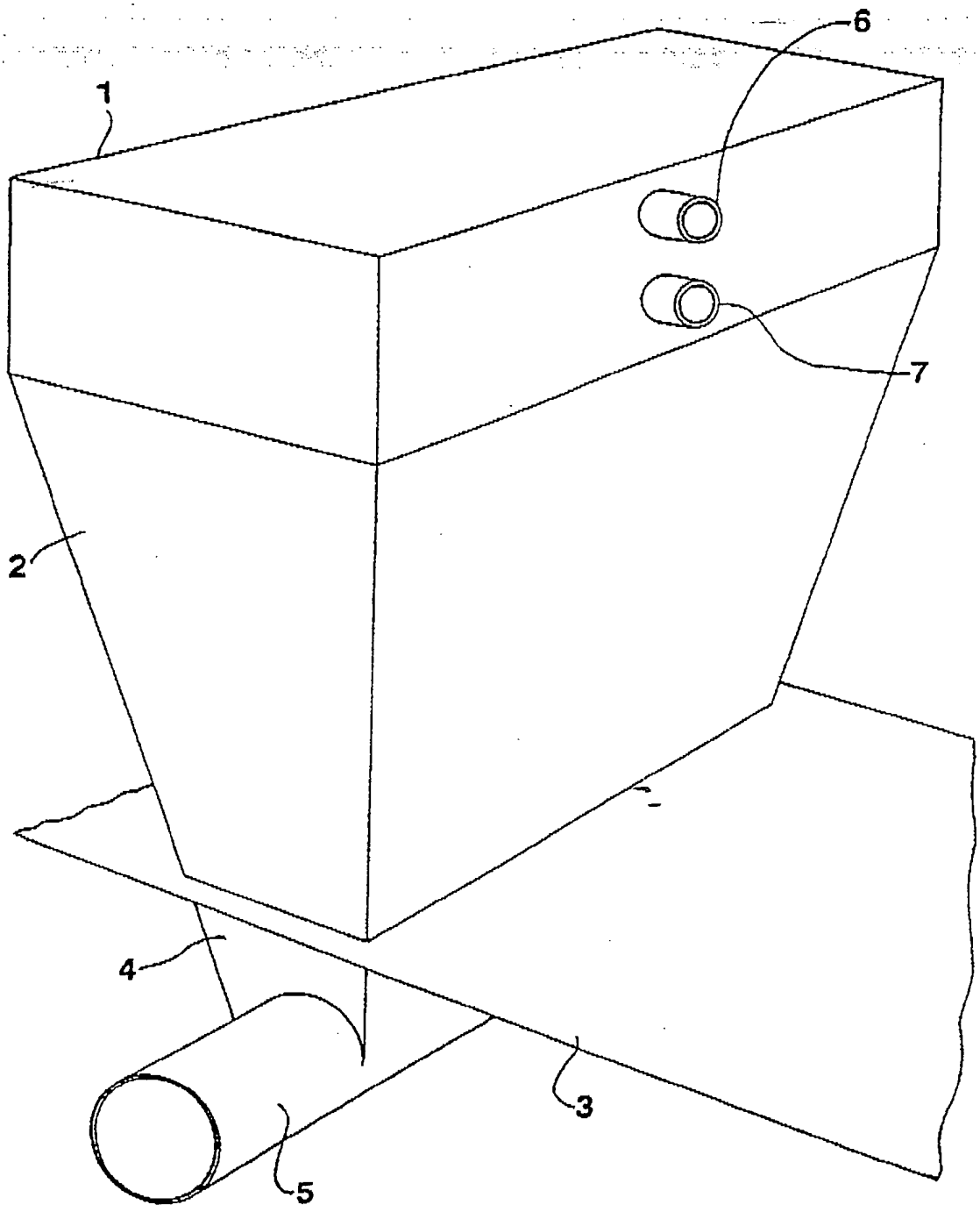


Fig. 2

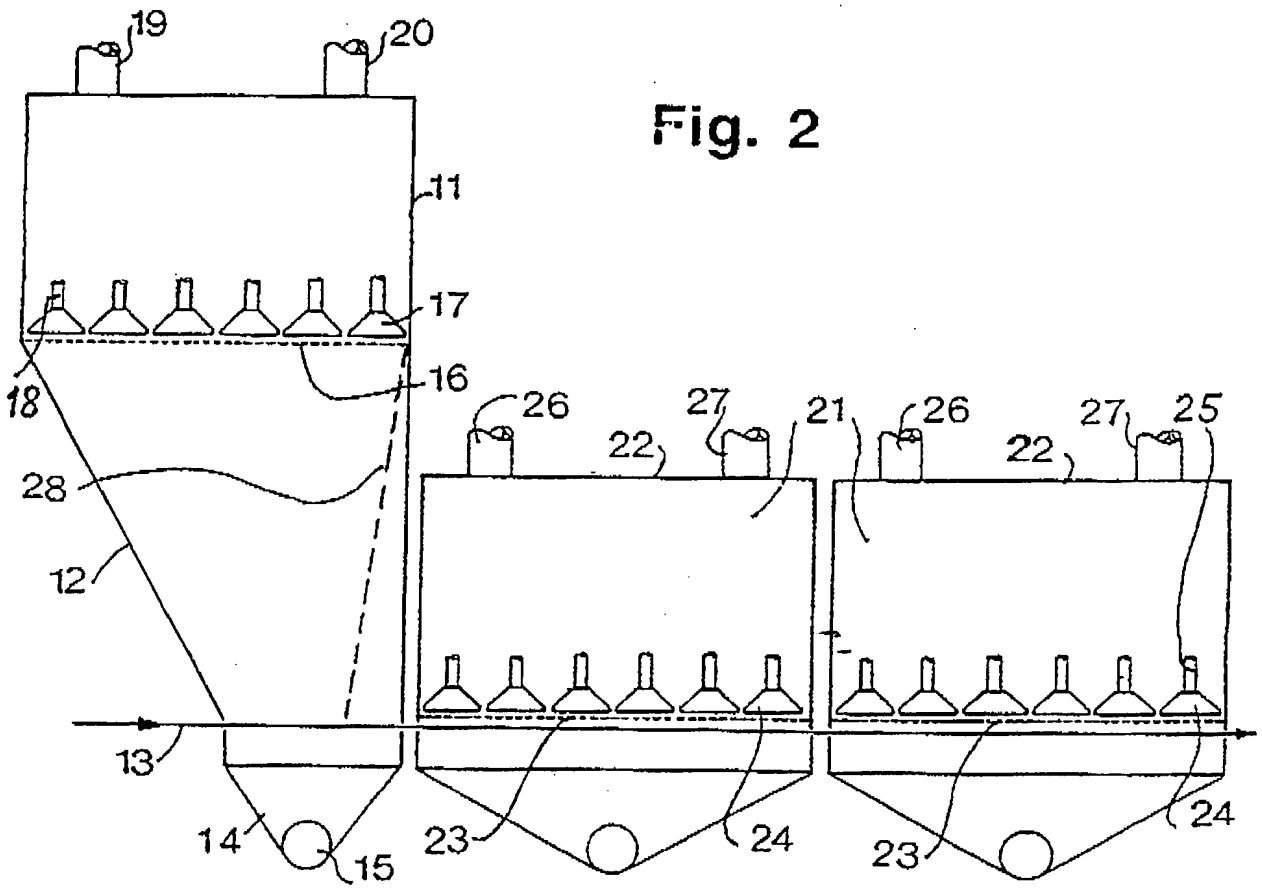


Fig. 3

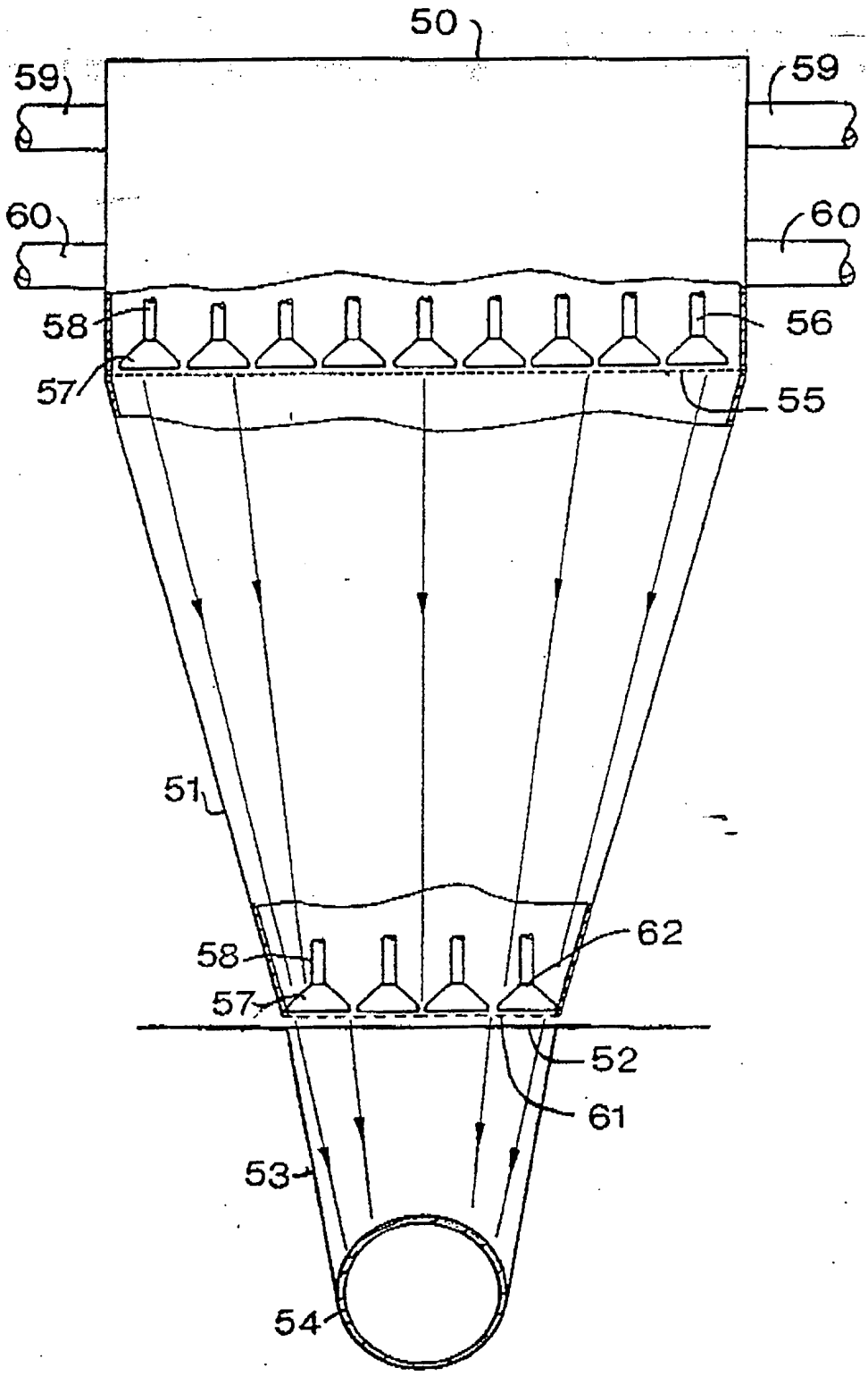


FIG.4

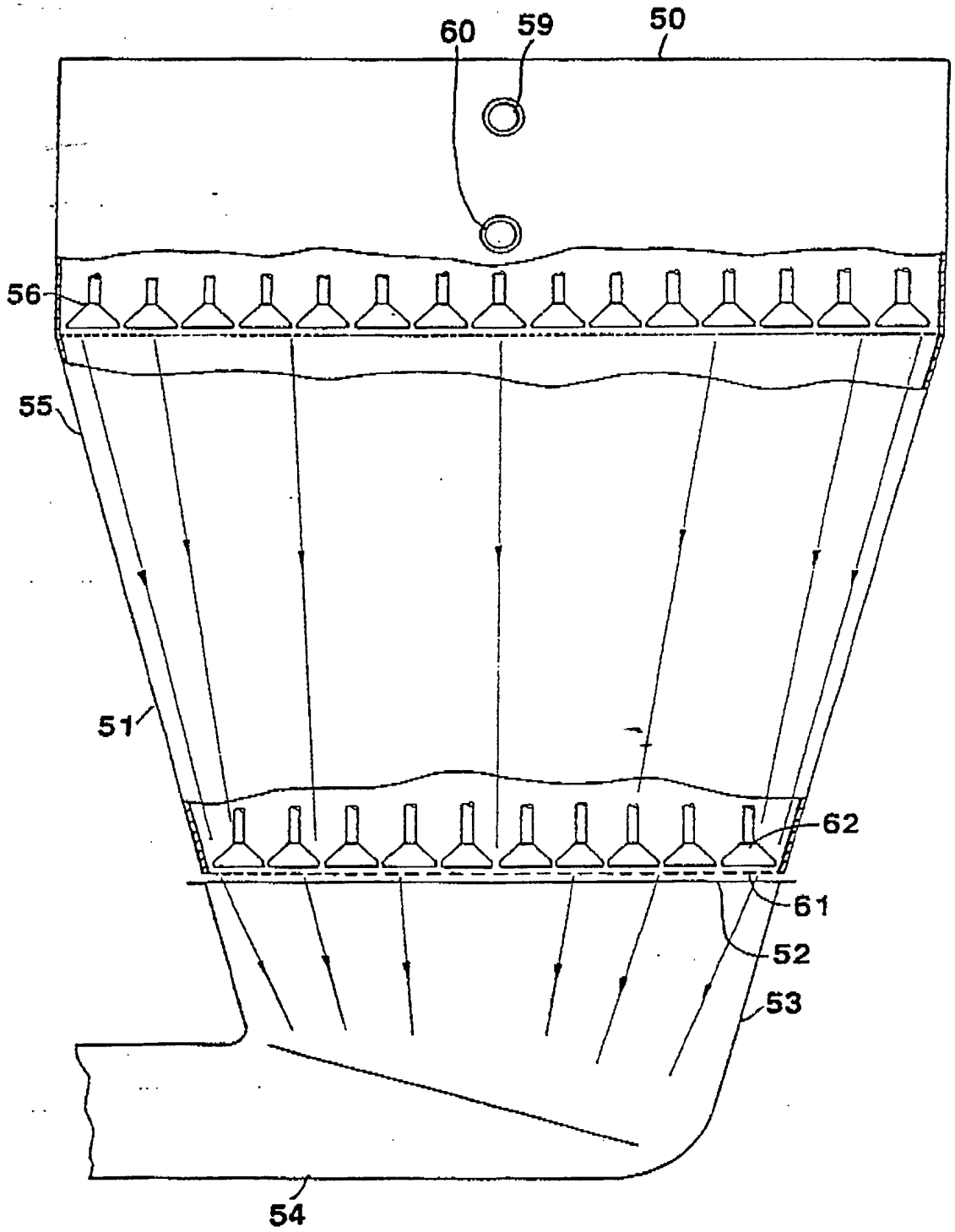


FIG. 5

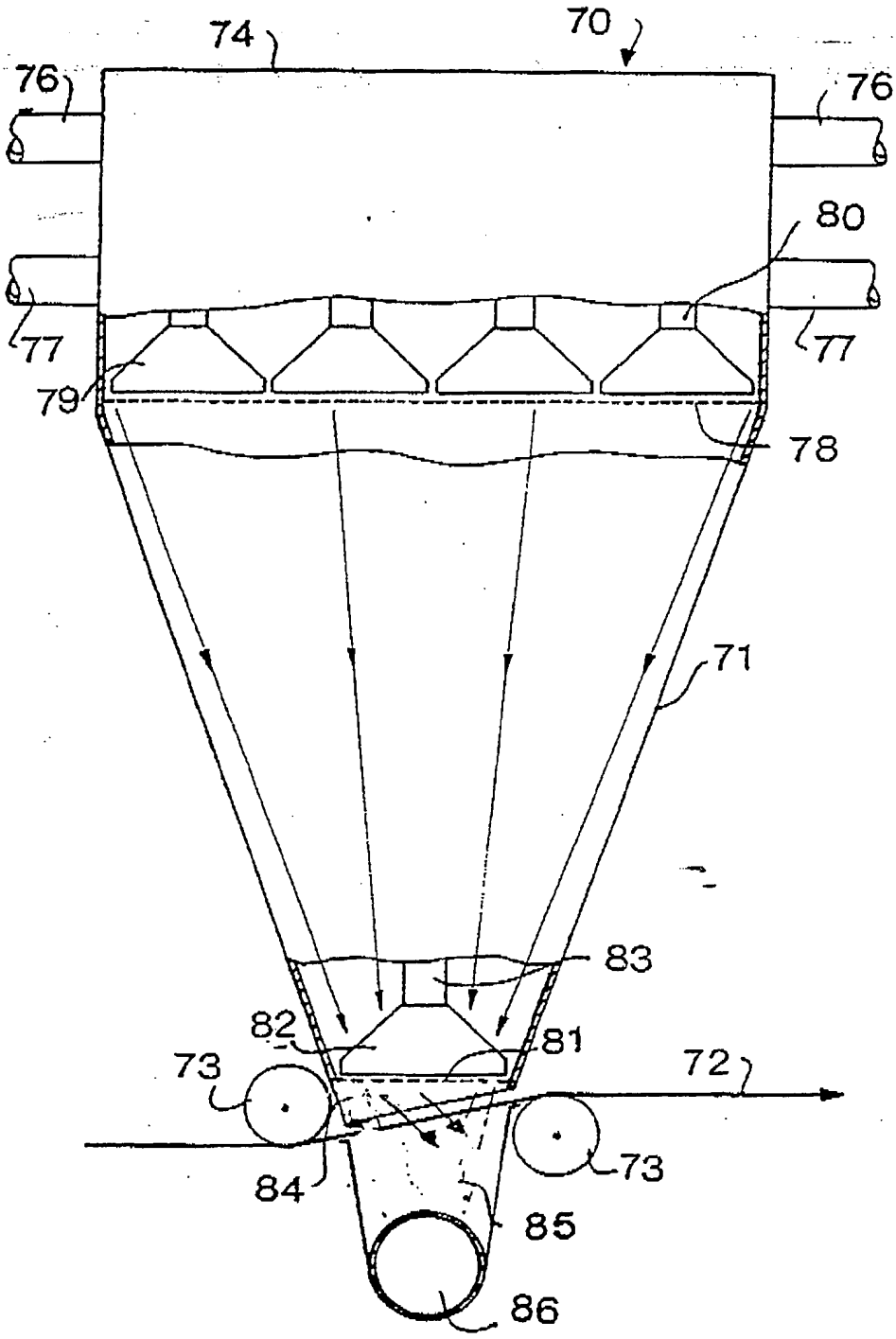
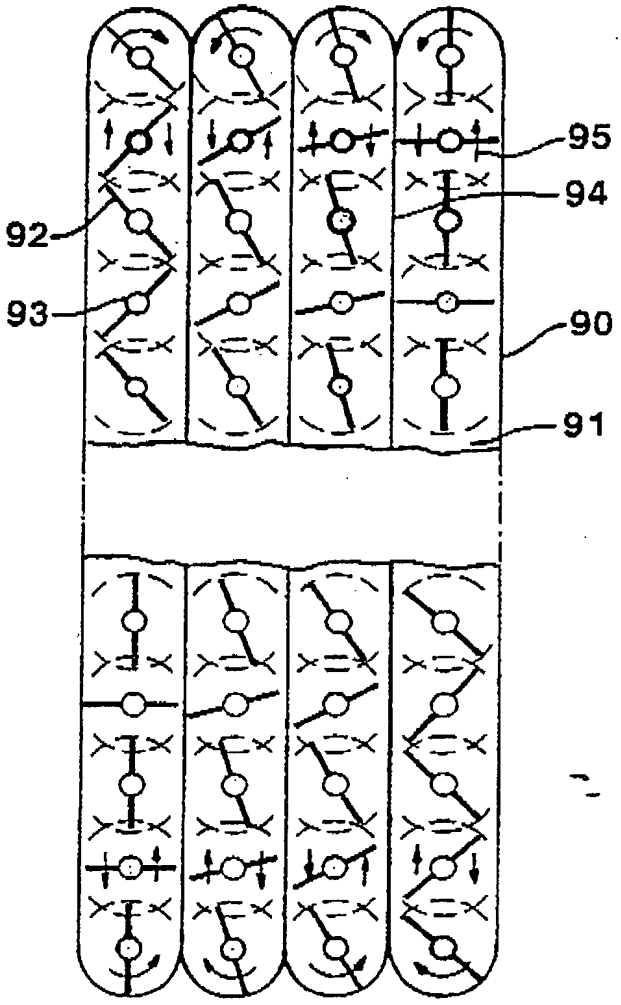


FIG.6



INTERNATIONAL SEARCH REPORT

International Application No PCT/DK 90/00248

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: D 04 H 1/72

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	D 04 H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	DE, C2, 2841251 (VSESOJUZNOE NAUCNO-PROIZVODSTVENNOE OB>>EDINENIE CELLJULOZNO-BUMAZNOJ PROMYSLENNOSTI) 3 May 1984, see column 3, line 48 - line 50; figures 2,6,8,10 --	1
A	DE, A1, 3420891 (YHTYNEET PAPERITEHTAAT OY JYLHÄVAARA) 13 December 1984, see the whole document --	1,4
A	DK, B, 153530 (JAMES RIVER-NORWALK INC.) 25 July 1988, see the whole document --	1,4

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* Special categories of cited documents:[10]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
9th January 1991	1991 -01- 11
International Searching Authority	Signature of Authorized Officer
SWEDISH PATENT OFFICE	Åke Larsson

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/DK 90/00248

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 90-11-28
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-C2- 2841251	84-05-03	CA-A-	1085128	80-09-09
		FR-A-B-	2413204	79-07-27
		GB-A-B-	2010934	79-07-04
		JP-A-	54093172	79-07-24
		JP-B-	59007820	84-02-21
		SE-A-	7811877	79-06-28
DE-A1- 3420891	84-12-13	AU-D-	2931684	84-12-13
		GB-A-	2141150	84-12-12
		SE-A-	8403097	84-12-10
DK-B- 153530	88-07-25	NONE		

CASO R. 4734

DOM. BREV. INT

N° 001/1503/002414

NOME Fratelli NONWOVENS SpA

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